

GEOLOGIC COLUMN AND UNIT DESCRIPTION

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	UNIT DESCRIPTION	ECONOMIC VALUE	REFERENCES
QUATERNARY	Alluvium	Sand, clay and gravel; thickness less than 10 meters	The surface soil, covering the Recent flood plains and the Pleistocene terraces, is 0.5 to 2 m thick and is composed of "tschernosem" and "leached tschernosem", according to HIRAI (1935). Tschernosem is fertile black muck, and leached tschernosem consists of black muck, fine-grained sand and loam, and is also fit for agriculture.	<p>Gold</p> <p>Placer gold derived from the gold-bearing quartz veins intruding the pre-Jurassic granite is found in the Recent deposits near Ho-lung-men.</p>	<p>HIRAI, Keizō, 1935, Study on soils in Manchoukuo: Kyōshū Imp. Univ. Agr. Dept.</p> <p>MONDEN, Shigeo, 1943, Fluorite and fluorite deposit: Kyoritsu Publ. Co., Tokyo.</p> <p>OGURA, Tsutomu, and MATSUDA, Kamezō, 1936, Volcanoes of the Wu-ta-lien-ch'ih district, Lung-chiang Province, Manchuria: Ryojun Coll. Engr.</p> <p>OHKI, Ken'ichi, 1936, Report on the mineral resources along the projected railway between Ren-ch'eng and Ch'i-kan (附圖): Unpub. rept., S. Manchuria Ry. Co.</p> <p>1939, Report on the mineral resources along the projected railway between Ren-ch'eng and Ou-p'u (附圖): Unpub. rept., S. Manchuria Ry. Co.</p> <p>OZAKI, Hiroshi, 1935, Report on the mineral distribution in Eastern Hsingan Province: Shina Kōgyō Jinhō (Manchuria Geol. and Mining Rev.), no. 53, Geol. Inst., S. Manchuria Ry. Co.</p> <p>SAITŌ, Rinji, compiler, 1940, Geological map of Manchuria and adjacent areas, scale 1:3,000,000: Manchoukuo Geol. Inst.</p> <p>SAITŌ, Hokoto, 1936, Fluorite in the lower reaches of the Kan Ho, Hsing-an Province: Unpub. rept., S. Manchuria Ry. Co.</p> <p>T'AN, H. C., and WANG, H. S., 1929, Geology along the Nen Chiang, Heilung-chiang Province: China Geol. Survey, Bull., no. 13.</p> <p>USHIMARU, Shūtarō, and others, 1937, Geology and geography of northern Manchuria: Geol. Inst., S. Manchuria Ry. Co.</p> <p>YAMASHITA, Sadao, 1935, Geology of the northern part of the Great Hsingan Range: Shina Kōgyō Jinhō (Manchuria Geol. and Mining Rev.), no. 83, Geol. Inst., S. Manchuria Ry. Co.</p>
	Quaternary basalt	b ₁ -c: lava cone basalt; thickness more than 100 m b ₂ : plateau basalt; thickness 150 - 300 m	The Quaternary basalt includes plateau basalt (b ₂) and lava cone basalt (b ₁ -c) which are in effusive contact. The lava cone basalt constitutes volcanoes along the K'o-lo Ho and the K'ia Ho. There are five volcanoes in the K'o-lo Ho district: Nan Shan (高 449 m above sea level), Hsiao-i Shan (小 374 m), Ta-i Shan (大 443 m), T'uan-tzu Shan (團 488 m) and Hai Shan (海 544 m). The rock is a black dense olivine basalt that erupted in the Recent age. The basalt on the north slope of Nan Shan is a dark gray scoriaceous orropy lava. The plateau basalt occurs chiefly in the eastern part of the map area. It is black or pitch-black; when fresh it is hard, compact and porous, containing visible olivine phenocrysts; is holocrystalline to holohyaline, showing an intersertal or radial texture. It erupted intermittently during the Pleistocene and Recent epochs.		
	Diluvium	Clay, sand and gravel; thickness less than 50 m	Diluvium, consisting of clay, sand and gravel, rests on terraces 30 to 50 m in relative height. The pebbles of gravel are rhyolite, quartzite and agate, 0.8 to 9 cm in diameter. The thickness of the diluvial deposits ranges between 0 m and 50 m. A drillhole at Nen-ch'eng showed the following sequence in descending order: clay (5.4 m), fine sand (4 m), clay (2.1 m), fine sand (1.2 m), clay (8.2 m), clay and fine sand (2.7 m), clay, sand and gravel (5.1 m) and clay (14 m), totaling 42.7 m thick. The ground water level lies at a relatively deep horizon, and four aquifers were found by drilling into the Pleistocene and Neogene deposits, but the quality of water is inferior due to iron and manganese.		
	Neogene formation	Shale, sandstone, gravel and bentonite; thickness 100 to 200 m	The Neogene formation consists of clayey shale, soft sandstone, gravel and bentonite. Lithologically the formation is difficult to distinguish from Diluvium, but the former is somewhat more consolidated than the latter. The Neogene formation in the upper reaches of the Nen Chiang was dissected, resulting in narrow gorges and high terraces 100 m above the river bed. The formation is overlain by the Pleistocene basalt (b ₂) and Diluvium (Dd) and rests upon the pre-Jurassic granite (g ₂). Hence, it may be correlated with the continental Pliocene formation beyond the Amur River or with the Upper Tertiary series (上 第三紀) near Cha-lai-nora (柴 林 諾 爾) in the western frontier.		
TERTIARY	Neogene basalt	Doleritic basalt; thickness more than 100 m	The Neogene basalt in the hills east of Ho-lung-men (高 龍 門) is a dark gray to brown, coarse, holocrystalline doleritic basalt. Unlike the Pleistocene basalt on the south, the rock has no visible olivine phenocrysts but contains microcrystals of augite and olivine in the groundmass.		
	Paleogene basalt	Olivine basalt and olivine dolerite; thickness more than 150 m	The Paleogene basalt exposed in the western half of the map area forms a large gently undulating lava plateau. It is sporadically found also in the hills between the Lu-men Ho (魯 門 河) and the K'o-lo Ho. The basalt is dark gray to black, and variable in texture, some being very porous and other dense, hard and vitreous. The rock near Mei-yao-tien (梅 姚 田) consists of three flows: in descending order, vesicular medium-grained basalt more than 20 m thick, fine-grained chalcodony-bearing basalt 50 to 70 m thick, and non-porous olivine dolerite 40 m thick. The basalt rests on the Jurassic-Cretaceous formation (Mj) near Mei-yao-tien and Pai-hen-li (排 恨 里), on the rhyolite (rh) 20 to 30 km northwest of Nen-ch'eng, and on the Jurassic-Cretaceous formation and the Jurassic andesite (Mja) near I-tzu-han (伊 吐 汗), and is overlain by the Diluvium (Dd) near Ta-ch'ing Shan (大 清 山) and by the Quaternary basalt (b ₂) near Souko-san and Ch'uan-p'ao (穿 炮). The basalt is cut on the northwest by a northeast-trending fault which runs through Ying-shen (營 申) and thrust the Cretaceous granite block to the southeast during the pre-Miocene epoch. Hence, the basalt erupted probably in the pre-Oligocene epoch.		
	Cretaceous rhyolite	Rhyolite, tuff and breccia	The Cretaceous rhyolite in the hills east of Nen-ch'eng consists of white to light brown rhyolite containing megascopic quartz phenocrysts, accompanied by tuff and breccia. It rests on the Jurassic-Cretaceous formation, the Jurassic andesite, pre-Jurassic diorite (d) and granite (g ₂), and is overlain by the Diluvium and the Paleogene basalt.		
	Cretaceous granite	Biotite granite, two-mica granite, hornblende granite and aplite	The Cretaceous granite, occurring as laccoliths and batholiths, is characterized by tabular joints, friable texture and more or less porphyritic structure. The rock near Hu-ti-ch'i (胡 提 池) is porphyritic coarse-grained biotite granite in association with two-mica granite, hornblende granite and aplite.		
	Jurassic-Cretaceous formation	Upper part (Cretaceous): tuff, sandstone, shale and coal; thickness more than 50 m Lower part (Jurassic): shale, bentonite, sandstone and coal; thickness more than 20 m	The Jurassic-Cretaceous formation, disconformably underlain by the Jurassic andesite (Mja) is sporadically exposed as follows: (1) The formation between the Lu-men Ho and the K'o-lo Ho consists of tuff, sandstone, agglomeratic sandstone, shale and thin coal seams. The shale near Nan-pai-kun-li (南 排 坤 里) yields <i>Eosteria</i> sp. of Lower Cretaceous age. (2) The formation near Mei-yao-tien in the Kan-ho coal field reveals the following sequence in descending order: green platy tuffaceous shale (11 m), black shale interbedded with three thin layers of bentonite (1 m), and gray conglomeratic sandstone (8 m) resting on augite andesite bedrock. The black shale yields plant fossils such as <i>Pityophyllum lindstroemi</i> Nath. (3) The formation near I-tzu-han consists of greenish gray tuff, agglomeratic sandstone, platy shale and a thin coal seam. The tuff shale 1.5 km south of I-tzu-han yields plant fossils such as <i>Czekanowskia rigida</i> Heer (late Jurassic), <i>Pityophyllum lindstroemi</i> Nath. (late Jurassic), <i>P. nordenskiöldi</i> Heer (Jurassic-Cretaceous) and <i>Podozamites lanceolatus</i> L. H. (Mesozoic). (4) The formation near Pa-yen-chieh (巴 延 切) consists of dark gray shale, light gray tuffaceous sandstone and a thin coal seam, and yields silicified wood. The formation near Mei-yao-tien, I-tzu-han and Pa-yen-chieh was assigned to the Upper Cretaceous by Chinese geologists in 1929 on the basis of fossils such as <i>Cephalotaxopsis</i> sp., <i>Zamites</i> sp. and <i>Czekanowskia</i> sp. However, H. OZAKI (1934) revised the age to Upper Jurassic.		
	Jurassic andesite	Basaltic andesite and biotite andesite; thickness 100 to 200 m	The Jurassic andesite (Mja) rests unconformably on the Jurassic volcanic complex (Mjv) near Ho-t'un (胡 屯), on the pre-Jurassic granite (g ₂) near Wu-chia-tzu (吳 家 吐) and on the granite gneiss (ggn) near Nan-pai-kun-li. (1) The rock near Mei-yao-tien is a basaltic andesite consisting of tabular plagioclase phenocrysts and grayish blue groundmass, and the apparent thickness is 20 m. (2) The rock near Liu-t'un (劉 屯), 12 km northwest of Nen-ch'eng, is a biotite andesite consisting of oligoclase phenocrysts and gray cryptocrystalline groundmass showing flow texture. (3) The rock near Ni-ch'iu (尼 邱) is a basaltic cryptocrystalline andesite.		
	Jurassic volcanic complex (Greenstone complex)	Diorite porphyry, andesite porphyry, propylite, diabase, dolerite, volcanic breccia and tuff; thickness 100 to 500 m	The Jurassic volcanic complex, previously known as greenstone complex or porphyrite, is exposed near K'ai-ho (開 河), near Ho-t'un, and in the northwestern part of the map area. It is a complicated assemblage of dark green intrusives and effusives, such as diorite porphyry, andesite porphyry, propylite, diabase, dolerite, volcanic breccia and tuff. The complex near K'ai-ho is intruded by an andesite porphyry dike which resulted in the fluorite ore deposits (refer to Economic Value).		
	Diorite	Hornblende diorite	Hornblende diorite is exposed near Wu-chia-tzu, 20 km northwest of Nen-ch'eng, and near Hua-ma-t'ai (華 馬 台) 5 km east of I-tzu-han. It is a marginal facies of the pre-Jurassic granite (g ₂), and its intrusion may have taken place a little later than that of the granite.		
	Pre-Jurassic granite	Biotite granite, hornblende granite, two-mica granite, leucocratic granite and gneissose granite	The pre-Jurassic granite is exposed in the eastern half of the map area. The rock is generally light gray to pinkish gray and coarse-grained. It includes biotite granite, hornblende granite and two-mica granite, consisting of feldspar, quartz and colored minerals. The rock grades into gneissose granite in places, and is locally intruded by many gold-bearing quartz veins. The rock 3 km southeast of Ch'a-ma-chieh (查 馬 切) is a light brown medium-grained leucocratic granite, consisting of quartz, feldspar and a few mafic minerals. Its southern marginal part abounds in quartz and grades into garnet-biotite orthogneiss.		
	Granite gneiss	Biotite orthogneiss, hornblende orthogneiss, muscovite orthogneiss and sericite-biotite-orthogneiss	Granite gneiss is probably a marginal facies of the pre-Jurassic granite. The rock near Liu-t'un is biotite orthogneiss, in association with hornblende orthogneiss and muscovite orthogneiss. The rock along the K'o-lo Ho and near Ho-lung-men is sericite-biotite orthogneiss showing a distinct gneissose texture. The rock near Ta-ch'ing Shan is garnet-biotite orthogneiss.		
PALEOZOIC	Paleozoic? (Sinian?) formation	Hornfels-like slate; thickness about 300 m Quartzite; thickness 300 to 500 m	The Paleozoic? (Sinian?) formation is exposed in the following two places: (1) The formation 2 km south of Ch'a-ma-chieh consists chiefly of quartzite 200 to 300 m thick, striking N 55° E and dipping 45° SE. (2) The formation 13 km west of Wu-chia-tzu consists chiefly of dark gray hornfels-like slate 300 m thick which was contact-metamorphosed by the intrusion of the pre-Jurassic granite.		
	Crystalline schist	Quartz schist or paragneiss; thickness unknown	Crystalline schist, consisting of quartz schist, is exposed only in the hills 3 to 8 km southeast of Ch'a-ma-chieh. The rock abounds in quartz, which suggests that it is probably a paragneiss derived from the nearby Paleozoic quartzite by the intrusion of the pre-Jurassic granite.		
(Column not drawn to scale)					